LAWS OF HEALTH FOR SCHOOLS

MALCOLMSON


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LAWS OF HEALTH FOR SCHOOLS

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BY

A. M. MALCOLMSON, M.D.

WITH THIRTY-FIVE ILLUSTRATIONS IN THE TEXT

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LAWS OF HEALTH FOR SCHOOLS

INTRODUCTORY

One of the greatest boons that a man can have is good health. With it, he is able to fill his proper place in the world, to do his work well, and to enjoy the doing of it. In his leisure time he can find profit and pleasure in games and hobbies. His mind is free from worry, he eats his food with a good appetite, and his sleep is sound and refreshing. All this may come to him if his health be good. But if he lose his health life becomes a burden, he ceases to enjoy either work or play, he is a nuisance to himself and to his neighbours. Nor can he look forward to a happy old age, for the man who loses his health very often dies before his time, and, even if he continues to live on, old age without good health becomes a greater burden than ever.

There are many ways in which ill-health may

come upon us. We may be lacking in strength from our earliest years, or we may, by want of care or merely for lack of knowing better, do our health much harm.

Many people have to live in places which are not well suited for keeping their bodies healthy, and some have to do work that may, unless care be taken, bring various kinds of illness with it. Much of this, however, can be avoided by simple means, and it is well that every one should know how to take care of his body, what to do and what not to do in order to make himself, as the old rhyme puts it, "healthy, wealthy, and wise."

When we say we are in health, we mean that all the different parts of our bodies are free from disease and are doing their work properly.

CHAPTER I

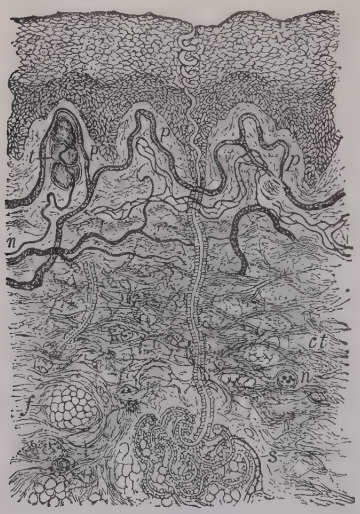
THE SKIN, HAIR, AND NAILS

In taking care of our health, we need to think of many different parts of the body, and perhaps it will be best to begin by learning something about the surface of the body, and what we must do to keep it in proper order.

The Skin.—The skin forms a complete covering for the whole body. It protects the parts inside from injury, it enables us to learn about things around us by the *sense of touch*, and it prevents the body from becoming too hot by producing *sweat*, or from becoming too cold by means of the layer of *fat* which lies underneath the surface.

The thickness of the skin varies in different people and at different parts of the body. The palms of the hands and the soles of the feet have skin that is both thicker and firmer than that of the face, for instance. There are, however, always several layers of skin placed one below the other, so that, as the outer layer

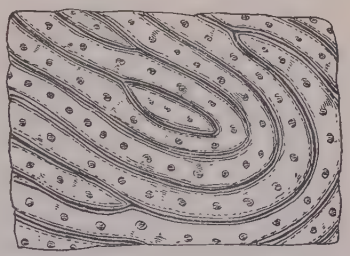
wears or is rubbed off, the layer below can take its place without damage being done to the body. To allow of this, new skin is always being produced at the undermost layer. One can tell quite simply that this wearing away of the skin is always going on. A proof of it can be found by taking a stocking that has been worn for a day or two and turning it inside out. On the inside of it will be seen a fine white powder, which is made up of the outer surface of the skin that has been rubbed off and has stuck to the wool of the stocking.



A Section of a Piece of Skin, showing the numerous layers. *s*, A sweat gland with long tube passing to the surface of the skin in a corkscrew manner. (Magnified.)

But besides the wearing of the skin itself, there are other things given off from the surface of the body. In the skin there are very small openings, for instance, that can just be seen by the eye, if we look closely at the front of the finger, and better with the help of a magnifying

glass. These openings are spoken of as the **pores** of the body. From some of them comes the fluid which we call sweat, while others throw out a kind of fat or oil. The sweat and the oil are both produced deep down in the lower layers of the skin, and each of them serves a purpose. The sweat coming to the surface evaporates and so prevents the body from getting overheated, and the oil keeps the skin soft and smooth. Besides these two, the skin also produces **hair**, on some places only in small amount, but elsewhere, as on the head, in the form of a thick covering. The **nails** grow from the skin at the ends of the fingers and toes, and give them firmness.



Surface of Skin from Front of Finger, showing the round openings or pores lying upon the ridges. (Magnified.)

QUESTIONS—

1. For what purposes is the skin of use?
2. How do we know that the skin wears off?
3. How is the worn-off skin replaced?
4. What is meant by the word "pores"?
5. Where does sweat come from?
6. What, besides sweat, does the skin produce?

CHAPTER II

THE CARE OF THE SKIN

The Care of the Skin.—We should know how to take care of the skin, and the most important thing we have to remember about it is that it requires to be kept *clean.* The sweat and oil that are given off by the skin, if allowed to lie on its surface, dry up and gather dirt. This is a thing to be avoided, if for no other reason than just that dirt is undesirable. But there is further cause for having this dried-up sweat and oil removed. If they remain on the skin, they tend to close up the pores, and very soon the skin would become unhealthy.

Cleanliness.—The ordinary way in which we keep our skin clean is by *washing* with water, and, in order to help the effect of the water, it is well to use soap along with it. *Soap* is so made that it dissolves off the fatty matter in which the dirt has collected, and both can then be carried away by rinsing in the water. Care should be taken that good soap is used, as some soaps are so coarsely made that they are apt to cause cracking and chapping of the skin. Especially where the skin is tender, as in the

case of babies and very young children, a soap that contains an extra supply of fat is always to be preferred.

Baths.—It is a good plan to have a bath once every day, and this may be done in the morning. For those who are able to stand it, a *cold bath* has a healthy and refreshing effect, and, even where this cannot be carried out, much good may be got from sponging the surface of the body with cold water. When either of these methods is used, care must be taken against catching a chill. The bath should be taken quickly, and the skin should be dried at once and rubbed thoroughly all over with a *rough towel.* The good effect of such a bath or sponging is not only that it assists in keeping us clean, but also that a glow of warmth is felt all over the body and helps in keeping us healthy. This glow is spoken of as the *reaction*, and should always follow as a result of the cold sponging. In some people no such reaction is produced; the skin remains cold, and the hands and feet blue and numbed. Such persons should avoid a bath that is entirely cold, but they may take a *tepid bath* or one slightly warm, the chilling effect of the bath being removed by the addition of some hot water to it. In no case should the vigorous rubbing after the bath be forgotten.

Those who do not take a bath every day should take care to keep the body clean by means of *warm baths* every few days, and certainly not less frequently than once a week. To avoid catching a cold, such a bath is best taken at night, so that the person may go straight to bed after it.

The **face** and the **hands,** which are not ordinarily covered by the clothing, naturally require more frequent and, especially in the case of the hands, more thorough washing. The reason for this is that these parts of the body are at all times coming into touch with the dirt and dust floating about in the air and lying on things that have to be handled, and they, therefore, become more easily soiled. It must be remembered, too, that our hands are used for work, and are liable to cuts and scratches. If we neglect the keeping of our hands clean, such cuts and scratches are very readily affected by minute bodies called *germs*, which live in the dirt, and, instead of healing easily, these wounds may *fester*, may allow poisons to enter the body, and may, in this way, do serious damage to our health.

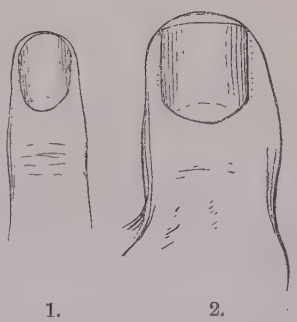
QUESTIONS—

1. Why should the skin be kept clean?
2. How may the skin be kept clean?
3. When and how should a cold bath be taken?
4. When and how should a warm bath be used?
5. What special attention should be given to the face and the hands?
6. What danger may there be in allowing the hands to remain dirty?

CHAPTER III

THE CARE OF THE NAILS AND THE HAIR

The Nails.—The hands and feet require additional care, because on the fingers and toes there are nails which have not only to be kept *clean*, but also have to be *cut*. The nails, if allowed to grow too long, would crack and break off, leaving ragged ends. For this reason it is always well to keep them fairly short. On the hands, the nails should be cut round, more or less in accordance with the shape of the ends of the fingers. The toe nails, however, should always be cut straight across, and not rounded off at the corners. If the toe nails are cut away at the corners, they tend to grow at these places into the soft skin which is pressed against



1. 2.

1. A Finger. 2. A great Toe. Notice how the nail of each is cut.

them by the boots, and to cause the painful condition known as *ingrowing toe nail.* The dirt which gathers under the ends of the nails may be gently scraped out with a blunt instrument, so that no wounding of the skin under the nail may take place. The same blunt instrument may be used to press back the skin which is apt to grow up over the lower part of the nail, but this skin should never be cut or scraped away. Beyond this, occasional scrubbing with a *nail-brush* is all that is required to keep these parts clean.

The Hair.—No part of the body becomes dirty more readily than the head, where it is covered by the hair, and it therefore needs extra care to ensure its cleanliness. The hair and the skin under it, called the *scalp*, should be washed thoroughly and frequently with soap and water, plenty of clean, warm water being used to rinse the soap entirely out when the cleansing is completed. It should then be thoroughly dried, and, in order to prevent it from matting together, it should be carefully *combed* and *brushed* all over. The oil that the skin produces in other parts of the body is also found on the scalp, and this is sufficient in many people to prevent the hair from becoming dry and hard. In some cases, however, it is necessary to keep the hair soft by applying something

of an oily nature to it, called a *pomade*. This is usually done by separating the hair here and there over the scalp and rubbing in a small quantity of the pomade at these places. The combing and brushing then spreads it more or less evenly over the whole of the head. There is a general idea that it is not good to *wash* the hair too often, lest damage should be done to it. But it should never be allowed to go without thorough cleansing for longer than a week or a fortnight, and should always be well brushed and combed at least every night and morning.

Hairs growing up from the deep Part of the Scalp. (Greatly magnified.)

Within recent years it has become very common for people, especially children, to go about without any cap or *covering* for the head. By so doing it is thought that the hair grows thicker and stronger, and is less

apt to fall out. It can, at least, be said that this is a habit which is likely to be healthy, and which certainly does not seem to do any harm to those who have accustomed themselves to it.

QUESTIONS—

1. Why and how should the nails be cared for?
2. What name is given to the skin on the head, and what grows from it?
3. How is the head to be washed?
4. What is a pomade, and how should it be used?
5. What, besides washing, must be done regularly for the hair?
6. What good is said to result from going about with the head uncovered?

CHAPTER IV

THE CARE OF THE TEETH

The Care of the Teeth.—Before we leave the subject of cleanliness, it will be well to mention another part of the body which should receive as much care, and receive it as frequently as the skin. The teeth require to be kept clean, not only for the sake of appearance, but because they may blacken and *decay* if not well cared for. Bad teeth may cause a great deal of ill-health, not only by interfering with the proper taking of our food, but also by acting in much the same way as an unclean wound in the skin, and allowing poison to enter into the body. It is through such decayed teeth that germs find their way into the *gums*, causing the painful swellings from which many of us suffer occasionally, and of which we speak as *gumboils*.

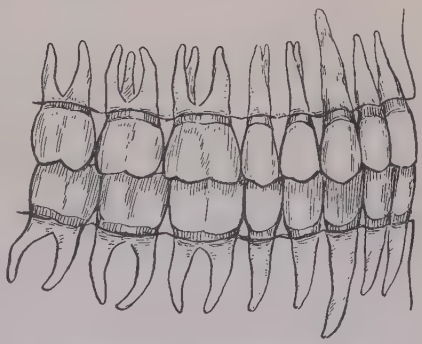
Natural Method.—Now there are two ways by which the teeth can be kept in good order. There is, first of all, the *natural* method. Our teeth are meant to be used for the **chewing** of food, and, when we come to study the food and

the proper way of eating it, something will be said about this. Much of the decay that is found in teeth nowadays is said to be due to lack of hard food; for thorough chewing of this would *naturally scrub* our teeth. Many of our meals are made up almost entirely of soft food that requires little or no chewing, such as porridge, puddings, and so on. If, after taking food of that kind, we were to eat something hard that needed to be well chewed, such as an apple, the hard fruit rubbing up and down on the teeth would clean away any of the soft food lying round the roots and in the corners. Such soft food, if left sticking about the teeth, is readily acted on by the *germs* in the mouth, and this is one of the ways in which decay commences, the more so since many of the soft foods contain a good deal of sugar, a substance in which germs easily grow and thrive. The movements of the mouth and tongue in chewing cause a plentiful flow of fluid, called *saliva*, into the mouth, and this assists in washing the teeth and carrying away any small pieces of food that may be lurking about them.

By giving the teeth and the mouth plenty of work to do in chewing the food, we help the teeth to grow strong and in *regular rows* in the mouth, and this tends also to prevent them

from decaying. If the teeth are set unevenly in the mouth, and pressed too closely together, they are apt to be injured and to decay. By attention to our food, and by taking care that we use our teeth thoroughly in the act of chewing, we may prevent much of the decay that is so common, and prevention, as the old saying puts it, is better than cure.

Artificial Method. — But there is a further way in which we can take care of our teeth. Just as we can clean our hands by rubbing them in water and our nails by means of a nail-brush, so we can help in keeping our teeth healthy by using a *tooth-brush.* If the tooth-brush is rubbed round the mouth and up and down over the teeth, it will clear away fragments of food that may be sticking there. Many different kinds of *powder* or *paste* are used to help the brush to do its work more thoroughly, but if the brush be dipped now and again during the



The Teeth on one Side of the Upper and Lower Jaws.

cleaning of the teeth in a cup of warm water containing a little *borax*, and if, after the brushing is over, the mouth be rinsed out with some of the same mixture, nothing further in the way of cleaning is needed. The teeth should be brushed night and morning, but especially *at night*, since pieces of food which are allowed to remain round the teeth during the hours of sleep give the germs their best chance of doing harm. If any signs of decay are seen on the teeth, or if there is any pain felt in them, it is well to go to a *dentist* to have the tooth put right, so that the decay already present may be removed, and further damage prevented. It is a good habit to go to the dentist every few months to have the teeth examined, and, if need be, put right, even though one can neither see nor feel anything wrong with them. The carrying out of this plan often means the saving of much pain and ill-health to the person who adopts it.

QUESTIONS—

1. Why should the teeth be taken care of?
2. What evils may be caused by decayed teeth?
3. What is the natural method of keeping the teeth in good order?
4. How is decay prevented by this method?
5. In what other way can the teeth be attended to?
6. How may borax be used to keep the teeth and the mouth clean?

CHAPTER V

CLOTHING

In order that we may be in good health, our bodies have to be kept reasonably warm. They must be protected from the bad effects of sudden changes from heat to cold. The most convenient way in which this can be done is by wearing *clothes*. The body is always producing heat, for everything we do, whether it be ordinary work, or exercise, or even thinking, means the putting out of energy, and energy always produces heat. To allow of this heat being kept round us, the body has to be covered with something which prevents the warmth so produced from being carried away.

A Silk-Worm on a Mulberry Branch.

According as the weather is cold or hot, we have to cover the body with clothing through which it is more or less difficult for the warmth to pass. Thus we say that some kinds of clothing conduct heat better than others. The kinds that conduct heat well tend to keep the body cool, while warmer clothing is of the kind that keeps the heat from escaping, and is therefore spoken of as being a **bad conductor** of heat. To know how we may clothe ourselves properly, we must learn what things conduct heat well or badly, how we get them, and how and when we should wear them.

Cotton Plant.

The Sources of Clothing.—Our clothing is got partly from plants and partly from animals. One great source of clothing is from the *wool* of sheep. This is made into worsted, and from worsted we get many different kinds of cloth—tweed, flannel, and so on. The *skins* of animals too

are used for clothing, many furs being worn in cold weather. *Silk*, which forms part of such cloths as velvet, satin, and crape, is got from the silk-worm. From the *cotton* plant there are made the cloths we know as cotton, calico, flannelette, and muslin. Linen, canvas, and cambric are some of the things made from the plant called *flax*. These are examples of the different kinds of cloth from which our clothes are made.

Flax Plant.

How do all these conduct heat? Wool and furs are the worst conductors of heat, and for this reason they make the warmest clothing. Next to these come silk and cotton. Linen conducts heat easily, and is therefore the coolest form of clothing. Wool may be made into a form of clothing which conducts heat still more slowly by being knitted or woven loosely. The reason for this is that the air between the threads becomes warmed, and such air is an even worse conductor of heat than the wool itself. Thus

the loosely knitted garment keeps in the heat better. In the same way, two thin woollen garments worn one outside the other are warmer than one thick one, because the warm air that fills up the space between the two thin garments prevents the heat from escaping to a greater extent even than the wool itself.

QUESTIONS—

1. Why does the body require to be clothed?
2. What is meant by the words "conductor of heat"?
3. What are the sources of clothing?
4. What kinds of clothing conduct heat badly?
5. Which kinds of clothing are coolest to wear?
6. Why are two thin woollen garments worn over one another warmer than one thick woollen garment?

CHAPTER VI

CLOTHING—(*continued*)

The colour of clothes has something to do with their warmth. The darker coloured clothes take in more heat from the sun than do the lighter. Thus black or dark blue cloth is warmer than yellow or white, and it is for this reason that, during summer, it is usual to wear light-coloured or white clothing.

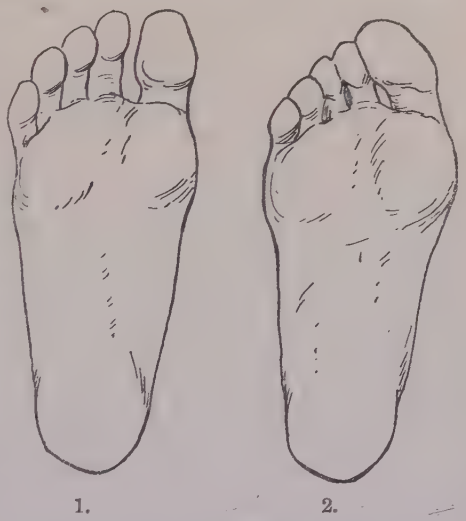
From what has been said of the different kinds of clothing, we can now understand why it is best to wear woollen things in cold weather. But there is another reason why wool is to be desired as a covering. Even when the weather is not so cold as in winter, it is sometimes safer to wear thin woollen garments next the skin. If the body tends to get warm when we are at work or during exercise, linen clothing will help to overcome this. But, even with linen clothes, we may become unduly warm and begin to *perspire*. The moisture remaining on our skin is apt to cool us down too rapidly after our work is over unless our clothing can dry up the sweat.

Now linen takes up moisture very slowly, while wool does so almost twice as quickly. For this reason it is much better and safer to do hard work or exercise in a light garment made of wool than in one of cotton or linen. Thus, in such games as cricket and tennis, where the player is putting out a great deal of effort for a time and then resting, it is best for him to wear clothes made from white wool.

From all this, then, we learn that, in this country at least, we should wear *woollen clothing next to the skin* summer and winter. The clothes should not be too tight, so that the movements of the body are not interfered with, and no part of the body made uncomfortable by too much pressure. Our clothes should be *changed regularly.* Those which we wear during the day should be taken off at night, and a light linen or cotton **nightdress** put on instead. This form of nightdress is best, because the heat of the body is kept by the bedclothes, and, in health, we should not perspire during sleep; so that the clothes we then wear do not require to take in moisture. Above all, we must be careful, by regular washing, to keep our clothes clean. They are constantly taking up oil and sweat from the skin as well as dust from the air and things around them. If not *regularly cleaned*, they would very soon become unhealthy,

and it would be of little use for us to keep ourselves clean if we were to undo all our work of daily washing by putting the body into dirty clothes.

The best covering for the head is a soft dark **hat** or **cap** in winter, and a lighter coloured hat of felt or straw in summer. In hot climates, a very light **helmet** covered with white cotton, and made to protect not only the head but also the back of the neck, is the best thing to wear. Particular care should be taken of the feet, as much pain and discomfort may be saved by having them properly shod. **Shoes** are better than boots in most cases, as they allow the ankle more room to move. The shoes should have good



1. 2.

1. The Sole of the Foot, showing the straight line formed by the inner edge of the great toe.
2. The same, showing the crushing together of the toes by the wearing of a badly made shoe.

broad soles, and the toes should have plenty of breadth also. The inner edge of the shoe should be straight, and not sloped to a point, as this tends to crush the toes together. The heels of the shoes also should be low.

QUESTIONS—

1. What effect has the colour of clothes on their warmth ?
2. For what reason other than warmth is it well to wear woollen garments next the skin ?
3. Which takes up moisture more quickly, linen or wool ?
4. What kind of cloth is best for the making of a nightdress, and why ?
5. Why should the clothing be regularly cleaned ?
6. What should be taken care of in the shape and the making of shoes ?

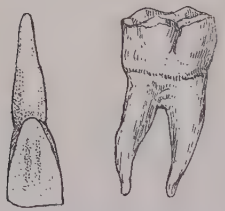
CHAPTER VII

FOOD AND DIGESTION

When one does any kind of work, some part of the body is always being used up, and before long the whole body would be worn out and work would have to stop if there were no means of preventing it from wasting. It is for this reason that we take **food**, and the food we eat gives the body the *power to do work*, and puts *new flesh* in place of the old that has been wasted. Then the body is constantly losing heat, and, although we may be well clothed, in time we should become so cold that we could not continue to live. Here again the food we eat is of use, being burned up to keep the body in a proper state of *warmth*. How, then, is all this brought about? It is brought about by what we call the digestion, and we must therefore find out what happens when we eat.

Digestion.—The first thing we do when we begin to eat is to take a bite out of a piece of food. That means that we use our teeth, and, in taking a bite, it is our *front teeth* that we use.

These have sharp cutting edges for this very purpose, and, when they have bitten off the piece of food, their work for the time being is done. To get this bite of food divided up into very small pieces we use our back teeth. These are known as the *molars*, and are broader and bigger than the front teeth, so that they can crush and tear the food. While this is being done, the *tongue* is rolling the food about in the mouth, and fluid called *saliva* is being poured in from the sides and the floor of the mouth and is mixing with the food, acting upon it so as to change some parts of it and make it ready for swallowing. When, by chewing and mixing with saliva, the bite of food we have taken has become a mass of pulp, it is swallowed, and passes down a tube called the *gullet* into the stomach.

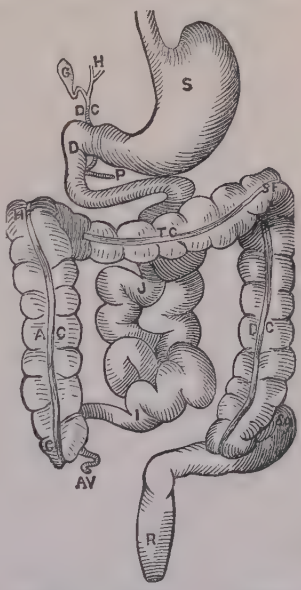


1. 2.

1. A front Tooth.
2. A Molar.

The **stomach** is one of the most important organs in the body. In shape it is very much like a large pear, and consists of a bag with a round opening at either end. The sides or walls have a thin *lining* not unlike that found on the inside of the cheeks. In this lining there are many minute openings through which fluid, called *the gastric or stomach juice,* is

poured into the stomach. This fluid is made in the deeper parts of the stomach wall, just as the sweat is made in the deeper layers of the skin and sent out through the pores. When food is taken into the mouth, a large supply of this gastric juice is sent through these openings into the stomach, and is there ready to act on the food as soon as it comes in from the gullet. The stomach, too, has the power to roll the food about, so that every part of it is thoroughly mixed with this fluid.



The chief Organs of Digestion. S, the stomach. D, J, I, AV, AC, TC, SF, DC, and R are different parts of the bowels. AV is the appendix.

After three or four hours, what one first of all took as a bite of food has been changed into a yellowish, *creamy fluid*, and, now that the stomach has finished its work, this is passed into the bowels.

The **bowels** consist of a long tube, wider at some places and narrower at others, coiled round and round inside the belly. Just as there were

openings in the wall of the stomach which poured out the gastric juice, so in the sides of the bowel there are many minute openings from which comes another fluid. Bile, also, comes from the *liver*, and pancreatic juice from the *sweetbread*. These fluids now act on the food, digesting it further and changing it into a *milky-looking substance*, ready to be carried away to the different parts of the body. Some part of everything we eat is of no use for food, and that is sent on through the bowels and is passed out of the body altogether in the form of what is called the *motions*. All that happens to the food, from the taking of it into the mouth until it is ready to be sent to the parts of the body where it is needed, is called digestion.

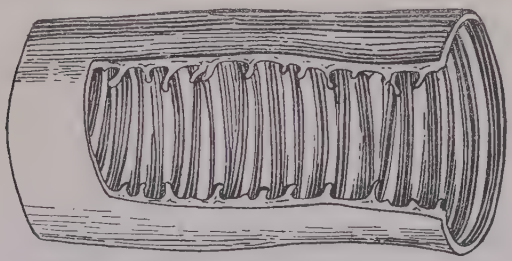
QUESTIONS—

1. Why does the body require food?
2. What is meant by the words "digestion of food"?
3. What changes take place in food while it is in the mouth?
4. How does food pass from the mouth to the stomach?
5. What happens to food in the stomach?
6. What happens to food after it leaves the stomach?

CHAPTER VIII

FOOD AND DIGESTION—(*continued*)

Absorption. — How, then, does this food, changed into the milky-looking fluid, leave the bowel and go to all parts of the body? This is done by means of the power that the bowel has to absorb the food. The lining of the bowel is arranged in a large number of *folds*. The milky fluid into which the food has been changed flows round these



Part of the Bowel. One side has been removed to show folds on the inner wall.

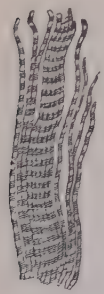
folds and soaks them. Gradually the fluid passes through the lining of the bowel, and, when this has happened, it is taken away by means of countless small *vessels* and gathered into one large duct or tube. Through this tube the fluid passes into the *blood*, and is then ready to be carried by it into the farthest parts of the body, giving strength and life wherever it goes. This is what is meant when we speak of the absorption of the food.

Keeping all this in mind, we must next learn something about the proper kinds of food, and about when and how we should eat.

Kinds of Food.—You have already learned that there are three chief effects which food has on the body. It helps to keep us warm, it gives us power to work, and it replaces the wasting that goes on as the result of work. Each of these effects is got most easily from a certain kind of food. The kind of food from which the body can most easily get heat is known as **fat.** People who live in very cold parts of the world feed to a large extent on fat, because they find that they require it for warmth. *Butter*, *cream*, and the *fat part of meat* are examples of fat foods. Foods which contain **sugar** and **starch** are good for giving the body the power required for work, and there are many forms in which we can get these foods quite cheaply. Thus among starches we have *potatoes*, *flour*, *rice*, *sago*, and many other foods got from plants grown in different parts of the world, and sugar itself is made from plants grown in various countries. The foods which are of most use in forming flesh and thus replacing the waste that goes on in

Globules of Fat lying among strands of fibrous Tissue. (Magnified.)

the body are got from the **animal kingdom**. *Butcher meat*, *fowls*, *fish*, *eggs*, and *milk* are common examples of this class. In addition to these, we require a good supply of **water**, as fluid is always being used up when the body is being exercised.



A small Piece of Flesh (greatly magnified), showing the fibres of which meat is composed.

The amount of each kind of food that should be used is important. If one fed on fats, sugar, and starches alone, one would not be able to live and work comfortably, any more than one could expect to be in good health when living entirely on butcher meat. For this reason it has been found best to use what is called a *mixed diet*, each of the different classes of food sharing in the various meals taken during the day. So important is this thought to be that, in places such as prisons and workhouses where large numbers of people have to be cared for and fed, the proper quantities of the various foods required to make a good diet have been calculated, and the inmates have their meals arranged accordingly.

QUESTIONS—

1. What is meant by the words "absorption of food"?
2. What are the three chief kinds of food?
3. What is the principal effect of each kind of food?
4. From what sources are the different kinds of food obtained?
5. What, besides food, do we require to put into our bodies?
6. What is the best kind of diet, and why?

CHAPTER IX

FOOD AND DIGESTION—(*continued*)

Cooking of Food.—We have seen that, if the body is to be kept healthy, the right kind of food must be used, but it is equally important that the food should be properly prepared for use, that it should be taken regularly, and that it should be eaten in the right way. Some foods can be eaten *raw*, and a large number of common fruits, such as apples, oranges, and bananas, require no cooking. Most of the food we eat, however, has to be prepared by being *cooked*, so that the harder parts of it may be softened, and the juices allowed to escape more easily. The cooking of the food makes it easier for the stomach to do the work that is needed before

Piece of Potato (magnified). The starch-grains are held together in a network, which has to be burst in the process of cooking.

the food can be taken up by the various parts of the body where strength and nourishment are required. Cooking, too, helps to get rid of things in the food, such as germs, which might otherwise do us harm and even cause ill-health.

When to Eat.—We have also to take our meals regularly. The stomach takes some time to get rid of a meal, and then requires to *rest* before a second meal is taken. It cannot work constantly without getting tired, any more than a man can go on working always without rest. For this reason it has been found from experience that it is best to allow about *four or five hours* to pass between one meal and the next; while, during the night, an ordinary healthy man is asleep and requires no food, so that the stomach can then have a longer period in which to prepare for further work. During these periods of rest no more food should enter the stomach, so that we should not eat between the regular meal-times. One must remember, too, that the stomach can be overworked by having too much food put into it at one time, while it may be unable to do its duty properly if one constantly eats too little.

How to Eat.—However good the food may be, and although it may be well cooked and taken at the proper time, we may still do harm to the body or fail to get the greatest

benefit from our meals if we do not know how to eat. Many people are in a constant state of ill-health because they never take time to eat their food properly. Food should be eaten *slowly*, and each bite should be well chewed and mixed with the fluid in the mouth before it is swallowed. A bite of meat has to be divided up by the teeth into small pieces, so that, when it has been swallowed, it will be easy for the stomach to act upon it. This cannot happen if the food is *bolted*, and, as a result of swallowing food that has not been chewed enough, the stomach has far too much work given it to do. It may manage to do the extra work for a time, but before long it will fail, pain will follow, and the health of the whole body will suffer. One should always be careful to take time when eating, and to have time to spare after the food has been eaten so that no bad effects may follow after a meal. As one should not begin hard work too soon after a meal, so also it is not well to take food just before going to bed. When this happens sleep is not likely to be so sound, and we may have bad dreams, be wakeful during the night, and rise in the morning feeling tired and unfit for our duties. Again, food should not be taken immediately before a hot bath.

QUESTIONS—

1. What effect has cooking on the food we eat?
2. How may the cooking of food tend to prevent ill-health?
3. How often should food be taken by a healthy person, and why?
4. What should be attended to in the eating of food, and what should be avoided?
5. What should one do after a meal?
6. What rule should be followed in taking food and sleep?

CHAPTER X

AIR

EVERYTHING that lives, whether a plant or an animal, requires **air**, and man, like all other animals, must have a good supply of air. Now, air is everywhere around us. We cannot see it, but we can tell that it is there both by hearing and by touch. When air is moved about rapidly, as it is when the wind blows hard, we can hear it whistling in the chimneys of our houses, or we can feel it on our faces. It is easy, therefore, for us to get a good supply of air. But it is equally important for us that the air we get should be the best possible, for we have to take it into the body, and its health depends to a large extent on the purity of the air we breathe. We must try to find out, then, which kind of air is best, and what is the best way in which to breathe.

Fresh air is present everywhere around us and fills up every empty space. Most outside air is perfectly good for breathing, although the air in the country may be more health-giving than the air found in large towns.

Air consists of a mixture of several gases, but

the important ones are called *oxygen*, *nitrogen*, and *carbonic acid*. In 10,000 parts of good fresh air there are 2096 parts of oxygen, 7900 of nitrogen, and 4 parts of carbonic acid. For the purposes of breathing, however, only two of these require to be studied. These two are oxygen and carbonic acid. If there were no oxygen in the air we could not possibly live, and people who are constantly breathing air that contains too little oxygen are apt to suffer greatly from ill-health. Carbonic acid, however, has exactly the opposite effect. The less carbonic acid there is in the air the better does the air become for breathing; and, if too much carbonic acid gets into the air and is taken into the body, we may be seriously harmed, or even killed, by breathing it. In order, therefore, to keep ourselves in good health, we must be careful to keep the air around us fresh, and this requires to be remembered all the more carefully, because, in breathing, the body is constantly using up oxygen and giving off carbonic acid. We shall see how this happens if we study what occurs when we breathe.

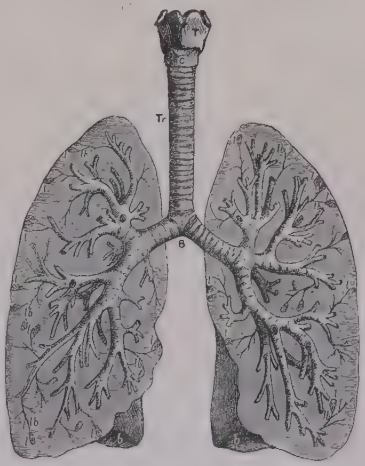
QUESTIONS—

1. Of what gases is air chiefly composed?
2. What amount of each gas is found in air?
3. How can we tell that air is everywhere around us?
4. What effect is produced on the body by air that contains too little oxygen?
5. What is the effect of air that contains too much carbonic acid?
6. Which is the more health-giving, town or country air?

CHAPTER XI

BREATHING

In ordinary breathing, the air should be taken in through the **nose**. As it passes along the *nostrils*, it is warmed and freed to a certain extent from the dust that floats about in it. To breathe with the mouth always open is harmful in many ways. The cold air passes straight to the back of the mouth, and is apt to cause many ailments in the throat, the nose, and even in the ear. The dust in the air, too, may get into the chest, and the germs contained in the dust as well as the dust itself may set up many serious diseases.



Tr, the Windpipe dividing into Bronchial Tubes at B. These are seen branching out in the two Lungs.

We should remember, then, always to *breathe through the nose* and to *keep the mouth closed.*

When the air has passed through the nostrils, it gets to the back of the mouth and passes down the **throat** into the **windpipe.** This is a round tube which runs down from the throat into the chest, and divides inside the chest into two somewhat smaller tubes, called the **bronchial tubes.** These tubes gradually divide up into many smaller and smaller branches, and through them the air finally reaches the lungs.

The Air-Cells. B, a bronchial tube dividing into two branches, each of which ends in air-cells (*av*). C, the network of small blood-vessels around the air-cells.

The lungs, of which there are two, one for each side of the chest, are made up of little bags or cells—**air-cells** they are called. These are grouped round the smallest of the tubes into which the wind-pipe has divided, much as the separate grapes in a bunch are set on the ends of the stalks, and the air passes from the tubes

into the cells. The *walls* of these cells are very thin and fine, and, on the outside of them, the *blood* is constantly flowing past in a large number of very small channels. The *oxygen* in the air inside the cells has the power to pass through the walls of the cells into the blood, and it is taken up by the blood and carried away to every part of the body.

Now the body is continually using up oxygen, because there is no work or exercise of any kind that can go on without it. In the doing of this work a large quantity of *carbonic acid* is made, and, if this were allowed to remain in our bodies, we would very soon be poisoned by it. To avoid this, the blood takes up the carbonic acid, and, just as it carried oxygen from the lungs out to the various parts of the body, so it carries the carbonic acid back from the outlying parts to the lungs. There the carbonic acid leaves the blood and passes into the air-cells, and so when we breathe out, a large quantity of carbonic acid escapes into the air.

QUESTIONS—

1. Name in their order the passages through which the air goes on its way to the lungs.
2. Why should air not be breathed in by the mouth?
3. What happens to the air as it passes in through the nostrils?
4. How many lungs are there, and in what part of the body are they placed?
5. What do you know of the formation of the lungs?
6. What happens to the air after it reaches the lungs?

CHAPTER XII

HOW THE AIR IS KEPT PURE

We see that, in breathing, we are constantly using up the oxygen of the air and making it impure by giving out carbonic acid. How, then, does the air continue to keep pure? You remember that in 10,000 parts of fresh air there are over 2000 parts of oxygen and 4 parts of carbonic acid. Air that has been breathed contains much more than four parts of the latter, but this is not allowed to remain. The **winds** move the air about, and in this way help to purify it. But the chief way in which the air is kept fresh is a very simple one. **Plants** need air, but in a way exactly the opposite of that required in animals. The plants take in carbonic acid and give out oxygen, and by this means the extra carbonic acid which we put out when we breathe is used up, and a constant supply of fresh oxygen is produced. It is for this reason that it is good to have many *open spaces* and *public parks* in our large towns, and this, too, explains why the air of the country is

purer and better than the air in the centre of a city.

Now, while nature arranges all this for us out of doors, it is not by any means so easy to keep the air inside of our houses fresh. And yet, if we are to remain in good health, we must have pure air wherever we are. When several people have been using a room for some time, and especially if they have kept the windows and doors of the room shut, the air they are breathing very soon becomes foul. Those inside the room may not notice this, but it is easily felt by any one coming into the room from outside. Such a person could tell at once that the room was *stuffy*. Now this stuffiness begins to be noticed when the *carbonic acid* in the room increases from four parts to *six parts* in the 10,000 parts of air, so that, when we are indoors, we cannot afford to go on for long without fresh air being let into our houses. Any means that we use for keeping the air of a room pure we speak of as **ventilation**, and we shall have to learn some of the simpler ways in which this can be carried out.

Every room has at least **one window** and **one door**, and a stuffy room can soon get a supply of fresh air if the doors and windows are opened wide and the wind allowed to pass through them. This is an excellent way of *airing* a

room, and, when possible, this plan should be carried out in every room for some time during each day; but this cannot be done unless the people leave the room, otherwise they would complain of a *draught*, and might easily get chilled. The draught is set up because the air of the room is being changed too quickly, and to avoid this we must use some other means whereby the bad air may leave the room and the good air enter it more slowly. Those who have studied ventilation carefully have found that the air of a room cannot be changed oftener than about *three times in an hour* without causing a draught, and for this reason we must find some means of having a supply of fresh air coming constantly into our houses. Then, too, the air must be allowed time to get slightly warmed before being breathed. All this may seem difficult to arrange, but there are several things which help towards this result.

QUESTIONS—

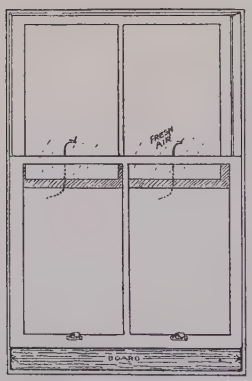
1. What changes take place in the air around us when we breathe?
2. What part of the air do plants and trees use up, and what part do they give out?
3. Why is the air of the country better than the air of a city?
4. What happens to the air in a closed room as the result of its being breathed?
5. What is meant by "airing" a room?
6. What is meant by a draught, and how often can the air of a room be changed without causing a draught?

CHAPTER XIII

VENTILATION

In cold weather, a room which is being occupied usually has an **open fire** burning in it. This is one of the best means of carrying off bad air. Air that has been breathed is warmed by the heat of the body from which it comes, and warm air is lighter than cold air, and therefore rises easily. The heat of the fire, too, tends to warm it further, and the bad air is drawn towards the fireplace and passes up the chimney. Now, since warm air rises, the upper parts of a room will always contain a certain degree of heat. If, then, we can *bring fresh, cold air into the upper part* of the room, the cold air, being heavy, will tend to come downwards and will get slightly warmed on its way down. For this reason it has been found that the best way to let fresh air into a room is to bring it in fairly high up. Another thing to which attention must be paid is that the fresh air must enter the room *in an upward direction*, otherwise a draught of cold air would blow down on to the heads of the people in the room.

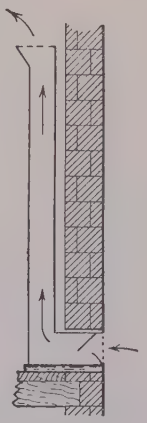
How, then, can all this be done simply? Several plans can be used, but it may be sufficient to describe two of them. One very simple and almost costless method of doing this has been called by the name of the man who first pointed it out. It is known as **Hinckes-Bird's method** of ventilation. It consists of a plank of wood about three or four inches in depth, and long enough to fill up the whole breadth of the window. This is placed at the bottom of the window frame, and the lower sash of the window is shut down on it. No air comes in below the window, as the plank of wood fills up the space there. But there is a space now between the two sashes, and the air can enter through this. The space between the sashes is high enough up in the room for this purpose, and the air enters in an upward direction. A glance at the accompanying diagram will show quite simply how this happens.



Hinckes-Bird's Ventilator.

Another method which may be mentioned for the ventilation of a room is one which is often used in schools. This is by means of what are called **Tobin's tubes**. Here an opening

low down in the wall of the room allows the air to pass through from the outside, and a tube running up the inner side of the wall leads the air up into the room. The top of the tube opens at a level of about six feet from the floor, and so the fresh air is sent out into the room fairly high up, and is at the same time directed towards the roof. There are many other simple ways of bringing a constant supply of fresh air into buildings, but these two common examples are sufficient to show how ventilation may be carried out.



Tobin's Tube.

One thing, then, which we must never forget is that, if we wish to be healthy, we must always have a good supply of fresh air, and we must therefore see to it that, summer and winter, during the night as well as in the daytime, some such means as those described are used for keeping the air of our houses fresh. It is well, too, always to have the doors and windows of rooms that are not being occupied wide open, so that the rooms may be thoroughly aired before we use them again.

In cases of consumption a specially plentiful supply of air is needed, but this is obtained,

so far as possible, by allowing the sick person to remain both day and night out of doors, sheltered only from the wind and rain. In this way he has the full effect of all the sunshine and fresh air that he can get.

QUESTIONS—

1. What is meant by the word "ventilation"?
2. What effect on the ventilation of a room does an open fire have?
3. How should fresh, cold air be allowed to enter a room, and why?
4. Describe a Hinckes-Bird's Ventilator.
5. What are its advantages?
6. What is a Tobin's Tube?

CHAPTER XIV

LIGHTING AND HEATING

CLOSELY connected with ventilation are the questions of the lighting and heating of rooms, and it may be as well to mention them at this point.

Lighting.—The natural method of lighting a room is by means of the **sun's rays**, and there is no better way of doing it. Every room should have plenty of *window space* to let the sunlight in. Sunlight is health-giving, and it is one of the most powerful means by which the germs of disease can be killed. Those who live in houses where the sun gets little or no chance of entering are apt to be pale and sickly, and may suffer from many weakening ailments.

During the hours of darkness, however, it is necessary to provide some sort of **artificial light.** *Candles*, *oil lamps*, and *gas* are common forms of artificial light. They have all one great disadvantage. In burning, they use up the oxygen in the room, and produce

carbonic acid and other hurtful gases. Now we have already learned that the people in a room by breathing the air of the room cause that air to become foul and poisonous. It is for this reason that ventilation has to be arranged. If, then, we add to the poisonous effect of breathing the air the effect of having one or more open lights burning in the room, it is easy to see that, during the time that artificial light is required, we must be even more thorough in our attempts to keep the air of our houses fresh. The habit, therefore, which many people have of closing windows and doors when darkness comes on, and the gas or the lamp is lit, is one to be very carefully avoided.

Another form of artificial light which is becoming daily more common is produced by means of *electricity.* This light has the advantage of not using up oxygen or producing carbonic acid, while at the same time it is clean and free from any unpleasant smell.

Heating.—In speaking of ventilation, it was remarked that an **open fire** in a room helped very greatly in keeping the air fresh, the reason being that the warm air escapes very rapidly up the chimney and draws the heated and impure air from the room. This and its cheerful appearance are the two great arguments in

favour of heating a room by means of an open fire. Its chief drawbacks are that it does not heat the room evenly all over, the air near the floor, for example, remaining colder than that in other parts of the room. In addition to this, we must remember that only a very small part of the heat produced in an open fireplace comes out into the room. The greater part of the heat escapes up the flue, and has no effect in warming the room or its occupants. To avoid this waste, it is customary with many people to used **closed stoves**, the draught necessary for keeping up the fire being led in by a pipe at the bottom of the stove and the fumes carried away to the outside by an iron pipe which acts as a flue. The cheerful appearance of the open fire is lacking in this case, and, if there be any fault in the stove or the flue, poisonous gases are apt to escape into the room.

For large buildings, such as schools, halls, and churches, it is usual to supply heat by means of **hot water** led through the various rooms and passages in pipes, the water being heated in a large boiler on the lowest flat of the building, and rising as it becomes hot into pipes connected with the upper part of the boiler. The water can do this, because, like air, it becomes lighter when heated and tends to rise. After passing through the pipes and giving off its

heat to some parts of the building, it returns again to the boiler to be reheated, entering the boiler at its lowest part. Somewhat similar arrangements for heating can be carried out by means of **steam** and also by **hot air**.

QUESTIONS—

1. What is the natural method of lighting a room, and why is it the best?
2. Name some of the common forms of artificial light.
3. What disadvantages has gas lighting compared with electric lighting?
4. What are the points in favour of having an open fire in a room?
5. What are its disadvantages?
6. What methods of heating large buildings do you know of? Describe one of them.

CHAPTER XV

WATER: ITS USES, NATURE, AND SOURCE

Uses.—Water is one of the necessities of life. It makes up quite a large part of the human body. It is constantly being used up when the body is doing work of any kind, and if it were not regularly supplied to us we should soon be unable to continue our work, and should, before long, die of thirst. In addition to the water we require for drinking, water is also needed for cooking. For washing the body and for cleaning our houses and streets, as well as for carrying on many important trades, it is necessary to have sufficient water, and all these things have to be taken into account when a *water supply* is being provided for large numbers of people, as in the case of our towns and cities.

Nature and Source.—Water is composed of two gases called *hydrogen* and *oxygen*, in the proportion of two parts of the former to one part of the latter. The great source of ordinary

water is **rain**, and, in places where there are few or no people living, the water that comes down from the clouds as rain may be wonderfully pure. Water, however, has the power of *dissolving* almost everything to a greater or less extent, and what it cannot dissolve it can carry with it. For this reason it is difficult for rain-water to be pure, especially near big towns. In such places the air is impure, as the result of the soot and dust and bad gases in it. When the rain descends, it washes these things down with it, some of them being dissolved, while others float about or, as we say, are *suspended* in it. Despite this, rain-water is quite good for washing and cleaning purposes, and in the country, where a large supply of pure water cannot always be had, it is still customary to catch rain-water from the roofs by means of large barrels which one may see standing at the sides of houses.

The water that falls on the ground may do one of two things. It may run down the surface of the ground, as it does to a large extent on the hillsides, or it may soak into the ground, especially if the soil is porous, as in the case of sandy soil. After soaking down for some distance, it may reach rock or some kind of earth that does not allow water to sink through readily. It then seeks its way along the top of such a layer of soil, until the layer comes to the surface

of the earth. There the water re-appears in the form of a **spring**. The rain that runs down the hillsides may finally reach a *lake* or a *river* and thus be carried to the sea, such water being known as **surface water**. Water that runs off cultivated fields is apt to be very impure, but on the open hillside, where the water of a rapid stream is constantly splashing over stones, it is made very pure by mixture with the air. Farther down its course, as a river, it contains drainage from fields, houses, and even towns, which again renders it impure and unfit for drinking.

QUESTIONS—

1. What are the chief uses of water?
2. Of what is water composed?
3. What is the great source of water?
4. Why is it difficult to get pure water?
5. For what purposes may rain-water be safely used?
6. What happens to rain-water after it falls to the ground?

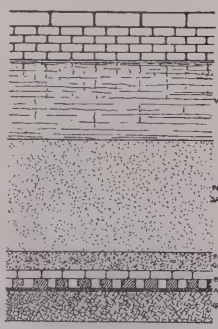
CHAPTER XVI

WATER SUPPLY AND DRAINAGE

Water Supply.—Water is provided for human use in several ways. It may be got from **wells**, and, if so, great care has to be taken that the water is not rendered impure by poisonous material soaking into the well from the ground near it. Such material may be decaying animal or vegetable substances, containing among other things large quantities of germs, and these might easily get into wells dissolved or suspended in water that had found its way through ploughed fields or land on which cattle have been grazing. The water of such a well would be dangerous for human use, and, speaking generally, a well must be deep to be pure. So, too, the water of rivers running through farm land or near towns, and into which refuse has been put, cannot be used for drinking, as it contains many poisons, and often produces disease by means of the germs floating in it.

Nowadays it is customary to get a water supply for a large town by building a **reservoir**.

This is done by choosing a valley into which flows the water from the hills. The end of the valley is closed by building a huge bank across it. For making this bank one must use materials, such as concrete and clay, through which water cannot escape. The water collected behind this high embankment is allowed to run into large iron pipes, and through them travels underground for, it may be, many miles, until it reaches the town which it is intended to supply. By means of pipes which branch along the various streets of the town, and from which smaller pipes go off, the water is finally led into the houses and other buildings. On its way between the reservoir and the town, arrangements are made for the water to run through beds of sand and gravel, called **filter-beds**, and in this way things that are hurtful and poisonous are taken out of the water, making it pure and fit for human use.



Filter-Bed, showing the layers through which the water has to sink. It runs out purified from between the bricks.

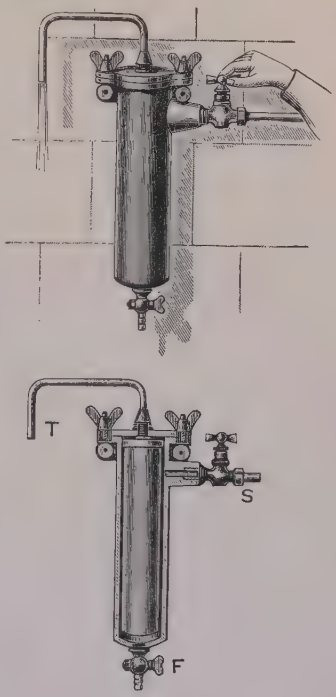
In addition to the harmful substances that may find their way into water, many things may be dissolved by it which improve it for use.

Thus water ordinarily contains a large quantity of *air*, and this makes it more pleasant for drinking. It can also in its passage through the soil take up *lime*, and the water supplied to a town usually contains more or less of this substance. If much lime be present in water, the water is spoken of as being *hard*, while water that contains very little lime, like rain-water, is said to be *soft*. Hard water may be softened by boiling, when the lime is taken out of it, and forms a layer on the inside of kettles and boilers. A certain quantity of lime in drinking water is no disadvantage, but if much lime be present, the water is not so good for cleaning and washing, as it does not dissolve soap easily, and therefore causes a large amount of waste.

When there is any doubt about water being pure enough for human use, and especially if there be only one source of supply, danger can be avoided by **boiling** the water before it is used for cooking or drinking. In this way the germs of disease are killed. Neglect of this simple rule has often caused much illness and many deaths, particularly during the progress of some of the great wars, such as that in South Africa, where more men died through drinking bad water than from wounds.

Another way in which water can be made pure is by means of small **filters**. These can

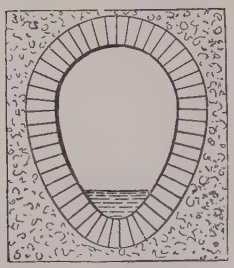
be fitted up in any house and the water passed through them before being used. Many of them, however, are not of any real value, and all have to be cleaned out regularly, otherwise they become a source of danger in themselves.



A common form of Filter. The upper figure shows the filter fixed to a wall. The lower figure shows the inside of the filter. S, pipe from the main. T, pipe for filtered water. F, tap for cleaning the filter.

Drainage. — One great purpose for which water is used nowadays is to wash away refuse and waste from houses and cities. By this means all waste substances, such as animal and vegetable matter, and the refuse from our bodies which we speak of as the motions, can be carried by means of pipes, called *drains*, leading from our houses to large *sewers* which run along under the streets. These join with other similar sewers and carry the sewage away to a distance from the town,

emptying into the sea or other suitable place. Water is used for washing down these pipes and for floating the solid matter of the refuse through them. By this means much that would be harmful to us is got rid of underground, the air of our houses and streets is kept pure and clean, and disease is prevented.



Sewer, showing the egg-shape.

In arranging for the **amount of water** to a town, sufficient allowance must be made to provide water enough for drainage as well as for drinking, cooking, and washing. In most British towns, *twenty to thirty gallons of water* a day are supplied for each person. This is reckoned to be a fair allowance for all purposes of trade and house use to which water is put.

QUESTIONS—

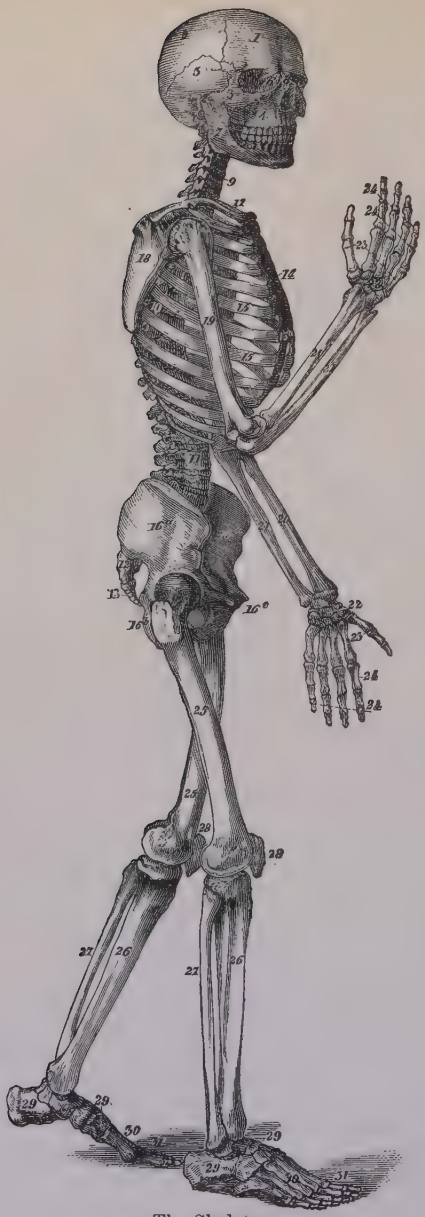
1. What are the dangers of drinking water from a well or from a river?
2. What is the common form of water supply provided for a large town?
3. How is this supply provided?
4. How is the water purified on its way to the town?
5. How can water be made pure inside of our houses?
6. What is meant by the word "drainage"?

CHAPTER XVII

THE SKELETON

We often hear it said that the body requires exercise to keep it in good condition. By this is meant that the different parts of the body have to be moved about regularly, as in walking, running, and so on. We must first learn, then, how the body can be moved, and, second, the best ways in which exercise can be taken. The different movements that the body can make are all carried out by means of our *bones*, *joints*, and *muscles*.

Bone is a hard substance, which forms the framework on which the body is built up. That framework we speak of as the skeleton, and it consists of a great number of bones, which vary in shape and size. Some are long and straight, some small and rounded, some flat, and some quite irregular in outline, and there are about *two hundred* of them altogether. Now let us try to learn something about the chief bones of the body, beginning at the **head** and going downwards. The bones which form the frame-



1, 2, 3, 4, 5, 6, 7, and 8, Bones of Skull.
9, 10, 11, 12, and 13, Bones of Spine.
14, Breast-Bone.
15, Ribs.
16, Haunch-Bones.
17, Collar-Bone.
18, Shoulder-Blade.
19, Bone of Upper Arm.
20 and 21, Bones of Forearm.
22, Wrist-Bones.
23, Bones of the Palm of Hand.
24, Finger-Bones.
25, Thigh-Bone.
26, Shin-Bone.
27, Smaller Bone of Leg.
28, Knee-Cap.
29, Ankle-Bones.
30, Bones of the Instep.
31, Bones of the Toes.

The Skeleton.

work of the head and face are spoken of as the *skull.* Several bones, some of them flat and others in a number of curious shapes, are joined together to make up the head. Thus we get the rounded shape of the forehead, the temples at each side, and the upper and lower jaws, with the teeth attached to them.

The head is joined by the **neck** to the **trunk** or body. Here again we have a large number of small rounded bones with many points projecting from them. These are set one on the top of the other, and form the long, bony column of the *spine* or backbone. This column enables us to stand straight, and gives rigidity to the trunk. To the sides of some of these bones are attached the *ribs*, which are thin and curved, and run out like a series of hoops to join the *breast-bone* at the front of the body. Inside the sort of barrel made by these bones and protected by them from injury are contained the heart and the lungs, which are most important organs in maintaining life.

The **arms** are attached to the upper part of the chest by means of the *collar-bones,* which run out at the lower end of the neck in front, and the *shoulder-blades*, which one can feel lying one on either side at the upper part of one's back. The collar-bone and the shoulder-blade meet at the point of the shoulder, and there

they come in contact with the bone of the *upper arm*, which runs between the shoulder and the elbow. The skeleton of the *forearm* —the part of the arm between the elbow and the wrist—consists of two bones. The *wrist* itself is made up of eight small bones lying alongside of one another, while five short bones form a framework for the *palm of the hand*, and fourteen for the *fingers and thumb*.

The **lower limbs** are attached to the spine by means of the *haunch-bones*, two large bones whose upper parts can be felt on each side of the body at the lower part of the trunk. The *thigh-bone* runs down from the lower part of the haunch-bone to the knee, and on each knee is a small bone which is called the *knee-cap*. The leg, from the knee down to the ankle, has two bones. One of these is a sharp bone, whose edge can be felt down the front of the leg. It is this bone that is commonly spoken of as the *shin*. Seven bones make up the *ankle* and the *heel*, while the *instep* and the *toes* consist of the same number of bones as the hand and fingers, placed in rows from one edge of the foot to the other. It is interesting to note that the great toe, like the thumb, has two bones only; while the small toe, like all the other fingers and toes, has three bones.

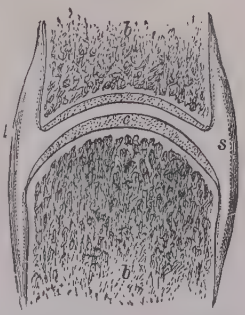
QUESTIONS—

1. By what means are the movements of the body carried out?
2. What is meant by the word "skeleton"?
3. What name is given to the bones of the head?
4. Of what does the "backbone" consist?
5. Name the different parts of the upper limb.
6. What is meant by the words "thigh," "ankle," and "instep"?

CHAPTER XVIII

JOINTS AND MUSCLES

Joints.—The bones of themselves would be of little use for moving about with were it not that they are held together by what are known as joints. There are many kinds of joints, and they vary greatly in the amount of movement which they allow between the bones. Thus some bones of the skull are so joined that no movement can occur at all between them, while other bones, such as those which meet at the shoulder, form a kind of joint that allows of a wide range of movement. In the common kind of *movable joint* the ends of the bones have a smooth covering of a substance known as *cartilage* or *gristle.* The bones are held together by strong bands or *sinews* which pass from the one to



Section of a Joint. *b b*, the two bones. *c c*, the layers of cartilage. *l*, sinews. *s*, sac for the oily fluid.

the other. Lining these sinews is a little bag or sac of tissue which contains an *oily fluid*. This oily fluid allows the bones to move smoothly on each other, while the gristle, which also helps in this way, serves the further purpose of preventing any feeling of jarring when a sudden movement is made. By such arrangements as these it is possible for the body or the limbs to be bent or straightened, to be turned round or moved from one side to the other. But the force by which these movements are made is supplied by the muscles.

The Bones of the Arm, showing how the forearm is raised by shortening and thickening of the biceps muscle (*Mu*).

Muscles.—The muscles consist of red masses of flesh arranged in bundles. One end of such a bundle is fixed to one bone and the other to another. Very often a muscle is attached to

a bone at some distance by a fibrous cord called a *tendon* or *sinew* or *leader*, like the cords in front of the wrist and behind the hand that bend and straighten the fingers from the muscles in the forearm. Each bundle of muscle consists of a number of very fine strands or *fibres*, and each of these has the power of shortening and lenthening again at will. Thus, when the muscle shortens and thickens, the bone to which it is attached is pulled on, and moves in a certain direction. An example of this is seen when the forearm is bent up. The muscle that causes the forearm to bend is called the *biceps*, and lies along the front of the upper arm. When the forearm is bent up, the biceps bulges out on the front of the upper arm, the bulging being due to the shortening and thickening of the muscle, which has its lower end fixed to one of the two bones of the forearm, and can thus by shortening pull on the bone and produce the bending movement. It is by such muscular action that all the movements of the body are carried out.

QUESTIONS—

1. For what are the joints of use?
2. Name the parts of which a joint is composed.
3. Which joints are least movable, and which most so?
4. Of what do muscles consist?
5. How do muscles act?
6. Name a muscle found in the arm, and state what happens when it is used.

CHAPTER XIX

EXERCISE AND REST

Now the bones, joints, and muscles all grow stronger with use, while, if they are not kept in regular exercise, the joints get stiff and the muscles remain soft and weak. More than that, **regular exercise,** especially exercise in the open air, helps to keep the body in good health, and enables the stomach and bowels, the lungs and the heart, and all the important organs to do their work thoroughly. All ordinary forms of **play** in which children indulge are therefore good for the preservation of health. Walking, running, skipping, and many other simple forms of exercise can be carried out regularly with benefit. Harm, however, can be done by taking too much exercise, or by making sudden, great, or prolonged efforts. Then one is apt to strain the muscles, and to cause permanent damage to the heart. For this reason, anything that requires the putting out of great strength, such as lifting heavy weights, or that causes a severe, prolonged

effort, as in running long-distance races, should never be undertaken without a special course of **training** having been first gone through. Training has the effect of making the muscles, sinews, and internal organs all more able to stand the strain of great exertion.

Regular Rest is just as much needed as regular exercise to keep the body and mind in health, and one of the most important forms in which we get it is that of **sleep.** The very young—*infants*—require a great deal of sleep if they are to thrive properly, and the greater part of the whole day is spent by them in this way. *Young children* above the age of infancy should have about twelve hours of sleep in the twenty-four, and *older children* should always have nine or ten. *Adults* require from six to eight hours' sleep. There is nothing more important in connection with health than the formation of good habits regarding sleep and the hours of sleep. Regular hours, both for going to bed and for rising from it, should always be observed, as this tends to produce sound sleep, and thus makes one fresher and stronger for the work of the new day. In this connection, too, it is well to remember that one should not sleep at night in the clothing worn during the day, for the clothing worn

during the day should be hung up to air through the night. The bed and bedding should be clean and comfortable, and the window should be left open all night to allow fresh air freely to enter the bedroom.

QUESTIONS—

1. What are the effects of exercise on the body?
2. What happens if the body is not exercised?
3. What simple forms of exercise do you know of?
4. What are the dangers of severe exercise, and how may they be avoided?
5. How much sleep should a schoolboy have each day?
6. What care should be taken regarding the clothing during sleep?

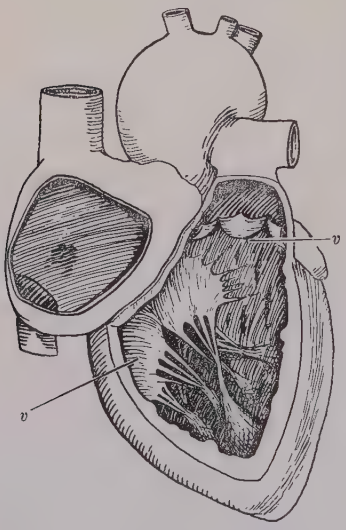
CHAPTER XX

THE CIRCULATION

The food we eat and the air we breathe would be of little use to us unless they were capable of being carried away to the various parts of the body. In the same way the waste substances that are formed in the different organs, as the result of the work they do, would become harmful to us if they were not taken away to parts of the body which could get rid of them. This work is very largely done by what is called the **circulation.** What do we mean when we speak of the circulation? The word itself refers to something that goes round. That something is the *blood*, which travels round through all parts of the body, and this circulation is carried on by means of the *heart* and the *blood-vessels.*

The **Heart** is a large organ which lies inside the chest rather towards the left side. It is so made that it consists of four hollow spaces or *chambers*, the walls of the chambers being composed of muscle. When blood flows into

the heart and fills the two upper chambers, the muscle forming the walls of these chambers pumps the blood into the two lower chambers. These, when full, push the blood on into the blood-vessels connected with them, and it is largely by the pumping action of the heart that the circulation is kept up. This pumping action can be felt as the *beating* of the heart by the hand placed on the front of the chest towards the left side.



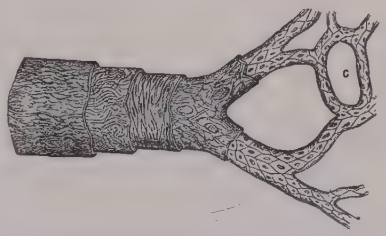
The Heart, showing the inside of two of its chambers, with blood-vessels entering and leaving it. The flaps opposite *vv* show two of the valves.

Each upper chamber has one or more openings for allowing blood to enter, and each has one opening through which the blood passes into the lower chamber. Each lower chamber has an opening for allowing the blood to flow out into the blood-vessels.

The opening into each lower chamber and the opening out into the blood-vessels are provided with little membranes which act as *valves*. These little valves—four in number—

prevent the blood from running backwards, and keep the circulation of the blood always in one direction.

The **Blood-vessels** are required for carrying the blood from the heart out to the different organs of the body. Thus there is one large blood-vessel called an *artery*, which takes the blood away on each side of the heart. Such a blood-vessel gradually divides up into smaller and smaller arteries until the blood finds its way into very small, thin tubes, called *capillaries*, so small that they cannot be seen by the naked eye.



An Artery dividing into branches, the smallest of which form capillaries (c).

In this way every part of the body has the blood carried to it, and it is from these minute vessels that the blood can give off what the body requires in the way of food and oxygen. It is into these same tubes that the blood receives the waste and poisonous substances that have been formed in the various organs. Thus the carbonic acid that the tissues make in doing their work is taken up by the blood in these small vessels. Other useless or harmful things, too, are taken into the blood in this

way, and all these the blood carries back through another set of vessels. These vessels gradually unite to form larger and larger tubes, just as the streams join together to form the large rivers. So the blood is gradually gathered into the largest of the vessels and taken back to the heart. The vessels in which the blood travels back to the heart are known as *veins*.

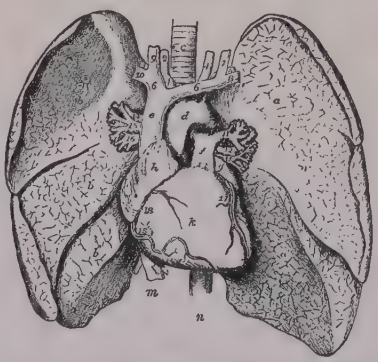
QUESTIONS—

1. What is meant by the word "circulation"?
2. By what organs is the circulation carried on?
3. Where in the body does the heart lie?
4. Tell what you know of the formation of the heart.
5. What kinds of blood-vessels do you know of?
6. What work does each kind of blood-vessel do?

CHAPTER XXI

THE CIRCULATION—(*continued*): WHAT IT DOES

How the Blood moves.—When the blood from the various outlying parts of the body comes back to the heart, it enters the upper chamber on the right side, whence it passes to the lower chamber on that side, and is then sent on through a set of blood-vessels to the lungs. By circulating through the lungs it gives up its carbonic acid and takes in a fresh supply of oxygen. Then it flows back by veins and enters the left side of the heart, first the upper chamber and then the lower. From this it passes into a large artery, and,



The Heart and large Blood-vessels, seen lying between the Lungs.
This diagram shows how closely the heart and the lungs are connected with each other.

through it and its branches, is sent out all over the body, returning to the right side of the heart again by the veins. Thus the blood is constantly circling through the body, and no more suitable name could be found to describe the work done by it than just the one that is used—*circulation.* One complete circulation takes place every half-minute throughout life.

What the Circulation does.—From what has been said elsewhere about the food and the digestion, it will not be difficult to see the part that the circulation plays in *carrying nourishment* throughout the body. In another chapter, also, it has been stated that the blood *carries oxygen* from the lungs to the other parts of the body, and brings carbonic acid back from the body to the lungs.

Other things that the blood takes up from the tissues of the body, things that would be hurtful or poisonous if allowed to remain behind, are got rid of in various ways. Some *harmful substances are carried* by the blood to the *kidneys*, and these organs take them from the blood along with fluid. The mixture thus produced is called the water or urine, and is expelled from the body altogether through the *bladder.* The *liver* also takes certain things from the blood, and these leave the body in the motions. The *skin*, too, extracts from the blood some of the

waste materials produced in the body, and gets rid of them in the fluid which we call sweat.

Another very important thing which the blood does is to *regulate the temperature.* When we grow hot the blood comes to the surface, the skin reddens, and the extra heat escapes into the surrounding air. When we feel cold the skin grows pale, the blood leaves it and seeks the internal organs, where the warmth is preserved.

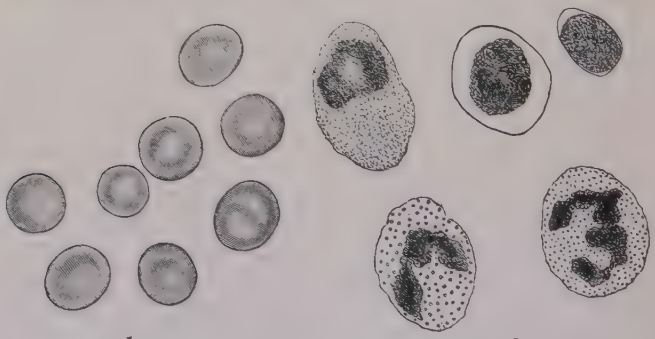
QUESTIONS—

1. How does the blood pass from the right to the left side of the heart?
2. What happens to the blood as it passes through the lungs?
3. What are the chief functions of the circulation?
4. What work do the kidneys perform?
5. How does the liver act upon the blood?
6. How does the circulation regulate the temperature of the body?

CHAPTER XXII

THE BLOOD

We have seen, then, how the blood is carried to different parts of the body, but we have still to learn what the blood is. If one cuts one's finger, a red fluid will flow from the wound, and this red fluid is the blood. Now, although



1. 2.

Blood Corpuscles. 1. Red corpuscles. 2. Different kinds of white corpuscles. (Magnified 1000 times.)

the blood appears to be fluid, it carries along with it minute solid particles, which are really small, living bodies. These bodies are called **corpuscles**, and they are always present in the blood. They can be seen only by means of a very strong magnifying glass. When so looked at, they appear to have different shapes and to

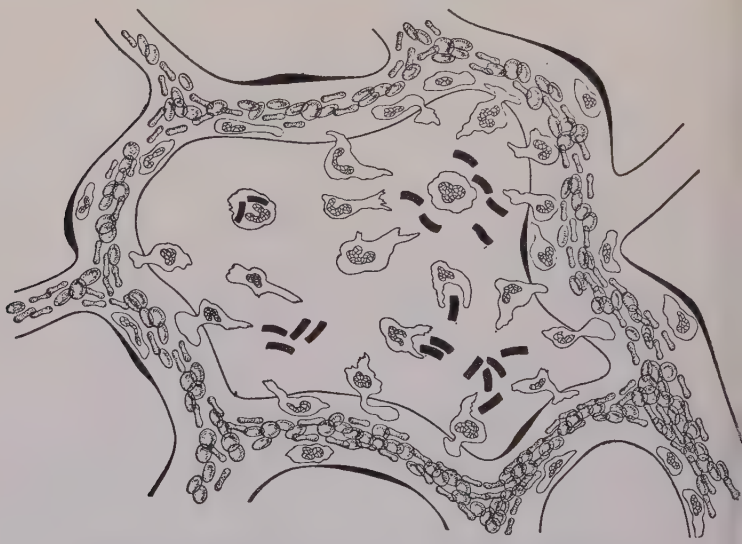
act in various ways. Some of them are round and yellowish in colour, while others are colourless and have quite an irregular shape. The round ones are spoken of as the *red corpuscles*, because, although they look yellow when seen singly, when they are seen in large masses together they give the blood its red colour. The others, which have no regular outline, are called *white corpuscles*. The fluid part of the blood is straw-coloured.

Each of these separate parts of the blood has a special duty to perform. The **fluid part** of the blood carries food and water to the organs of the body. It also takes away the waste substances from the tissues, carrying them to the kidneys and other organs, which take them from the blood and get rid of them out of the body.

The *red corpuscles* contain a substance which can unite easily with oxygen, and they are responsible for carrying fresh air to all parts of the body.

The *white corpuscles* have a great deal to do with protecting the body from disease. Many serious illnesses are caused, as we already know, by germs. These may enter the body at various places. When germs do find entrance to the body, they have to be killed off so that we may not suffer from the diseases they produce. When the body is in good health the white corpuscles are able to do their duty

thoroughly. They can leave the blood, worming their way through the walls of the blood-vessels near the place where the germs have entered. They surround the germs and kill them off by the simple method of eating them

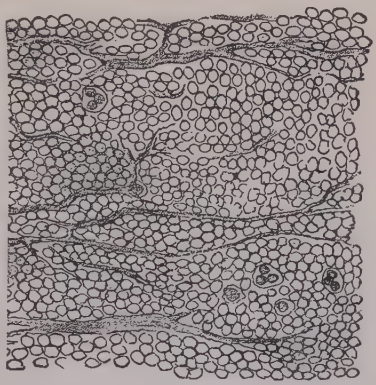


White Corpuscles passing through the walls of blood-vessels and surrounding the germs to kill them. (Greatly magnified.)

up. In this way we are able to escape many serious ailments, and, in order that the white corpuscles should be able to fight successfully against the germs that attack us, it is important that we should take care to keep all our organs in the best condition.

But there is another duty that the white

corpuscles have to do. When a blood-vessel is cut, as often happens in the case of a deep wound, *bleeding* takes place from the cut end of the vessel, and death might soon occur from loss of blood. It is due to a substance which the white corpuscles send into the blood on such occasions that the blood gradually **clots** or becomes solid, thus forming a plug in the end of the cut vessel and stopping the bleeding.



A Blood-Clot, showing how the corpuscles are massed together by strands of solid substance to form a plug.

The blood, then, consists of a fluid part which takes charge of the nourishment of the body; of red corpuscles for giving oxygen to the body; and of white corpuscles which act in warding off disease, and in helping to cause clotting of the blood when the body is injured.

QUESTIONS—

1. What is blood?
2. What corpuscles do you know of?
3. What is the purpose of each kind of corpuscle?
4. What duty does the fluid part of the blood do?
5. How do blood corpuscles act toward the germs of disease?
6. What is meant by the clotting of blood, and how does it occur?

CHAPTER XXIII

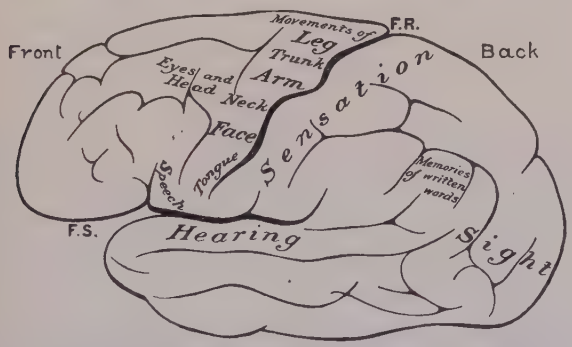
THE BRAIN AND THE NERVES

We have learned that the body is made up of a great many organs, each of which has some duty to do. The muscles are of use in allowing movement to take place; the stomach and the bowels have to do with the digestion of food; and the heart has to pump blood to the various parts of the body. All these things, however, have to be kept going at a proper pace, and there is a set of important organs in the body which keep the actions of all the other organs under control. It is for the purpose of controlling the whole body that we each possess a *brain*, a *spinal cord*, and *nerves*, and we must try to learn something about these.

The **Brain** is a large and important organ which almost fills up the hollow inside of the skull. Running down from the lower part of it and filling up a canal in the centre of the spine is the **spinal cord**. Both organs are made up of tissue that is grey in colour in some parts and white in others. From the brain and spinal cord, nerves can be seen branching off. These

nerves are white cords of varying thickness, and they run out to all parts of the body.

What, then, is this set of organs used for? In the first place, it is with the brain that one *thinks*. In learning lessons, in planning how to do any piece of work, or even in playing a game, the brain is being constantly used.

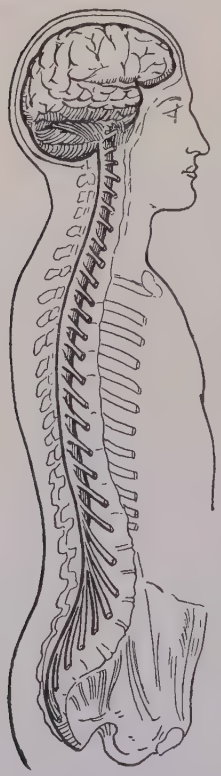


The left side of the Great Brain, showing the parts which take charge of movements in the body.

The only time when the thinking part of the brain can rest is during sleep.

The brain, too, has to take charge of the *movements* of the body. Whenever we wish to do anything, even the simplest action, the brain is the part of the body in which that action is set going. Thus, when the arm has to be raised above the head, the brain wills that such a movement should take place; it sends a message down the spinal cord, and through the nerves

branching off from it, to the muscles of the arm; these muscles are set in motion, and the arm is raised. All the ordinary movements of the body take place in such a manner as this. How the brain is able to do this we cannot tell, but we know that it does so, because when certain parts of the brain are injured, either by an accident or an illness, the muscles controlled by those parts of the brain lose their power and cannot move. We then say that that part of the body has been *paralysed*.



The Brain and the Spinal Cord, with Nerves going out from the latter.

But besides having the control of thought and movement, the brain serves a most useful purpose in another way. We can tell when we look at a thing what shape it has, what colour it is, whether it is near or far away, and so on. This we do by using our eyes. But the eyes alone could not enable us to do this, were it not that they send to the brain messages regarding the things they *see*, and the

brain makes out the meaning of these messages, so that we know what we are looking at. In the same way we *hear* sounds, and the brain tells us what these sounds mean. It is also by the brain that the other senses, as they are called, of *taste*, and *smell*, and *touch* are really made clear, although the tongue and the nose and the skin are the parts by which the work is first of all done. These are all connected with the brain, either directly or through the spinal cord, by means of **nerves**, so that the brain can know constantly what is going on in the different parts of the body.

There is another set of nerves closely connected with the set already mentioned. These are known as the **sympathetic nerves**, and differ from the others in this, that they have to do with the action of organs, such as the stomach, the bowels, and the blood-vessels, that are not directly under the control of the will.

The brain, the spinal cord, and the nerves require *food* like all other parts of the body, and, in addition, they need rest. *Sleep* is the great means by which these organs are kept in health. If one works for a long time without sleep, or without taking enough sleep each night, the nerves become exhausted, and serious illness may follow.

QUESTIONS—

1. What organs of the body are responsible for the control of all the other organs?
2. Where are the brain and spinal cord to be found, and of what are they composed?
3. What are nerves, and where do they come from?
4. What duties does the brain perform?
5. What are sympathetic nerves, and what organs do they control?
6. What do the brain, the spinal cord, and the nerves require to keep them in health?

CHAPTER XXIV

INFECTION AND DISINFECTION

When the different parts of the body and the best way of caring for them were being considered, the word **germs** was often mentioned. We already know that these are very small, living bodies which can enter any of the organs, and may set up disease in them. How to avoid this in many cases you have already learned. But there are some diseases known to be caused by germs, and others probably due to a similar cause, which can spread very quickly from one person to another, and these diseases we speak of specially as **infectious diseases.** They spread most easily where there are large numbers of people, particularly young people, spending a good deal of their time together in one place. This is just what children do in school or at play. As a result, when one of them suffering from an infectious disease comes into *contact* with the others, he is apt to cause in them the same illness from which he is suffering. He is said to *infect* them with the disease. Another

way in which disease passes from one person to another is by *coughing* or *sneezing*. One should therefore always turn the head aside in coughing and sneezing, or hold the hand before the mouth and nose. Still another manner in which people become infected is by *dust* or *food*, or even the *foul air* from drains, which may contain the germs of disease. Thus, dust may be infected by consumptives who have spat in it; food may be soiled by flies settling on it; and drains may contain the motions of sick people. Against this **indirect infection** it is much more difficult to guard.

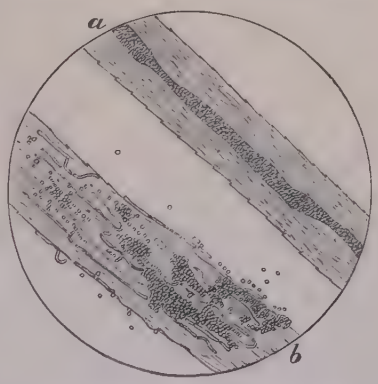
Many of the infectious diseases are known by name to all, and, as examples of them, one may mention three such common ones as *measles*, *scarlet fever*, and *mumps*. Any of these diseases may be very serious when one suffers from a bad attack of it, and thus means have to be taken to prevent such an illness from spreading.

It is for this reason that people suffering from such diseases are not allowed to mix with others, even of the same family. The *patient*, as the person who is ill is called, is kept in a room by himself, or may be taken away from home to a hospital where such diseases are cared for. If he be a schoolboy, his brothers and sisters are not allowed

to come to school again until it is quite certain that none of them has caught the disease. Their clothing, too, has to be made free from any germs of infection that may be on it. This is done in various ways, but however it is done, we speak of the means as **disinfection**. Attention must be paid to many other rules in order to prevent the spread of these diseases, and so important is it to check infection that, all over the country, men are specially employed for this purpose alone. Such men are at work in all our large towns and cities, and the duties they do are spoken of as the care of the *public health*.

Apart from these ordinary infectious ailments there are some forms of disease, especially in the skin, that are common in children. Such diseases, too, can easily spread from one child to another if a healthy child touch the part of skin in which another child has the disease. As an example we may mention **ringworm**, which is caused by a germ, and is commonly found in the skin and the hair of children. It is often spread by the cap of an infected child being worn by another, or by brushes and combs that have been used by some one suffering from the disease. It spreads in round patches on the scalp or skin, and the ring-shaped areas that it

forms have given the disease its name. Ringworm may readily spread from child to child until a large number are suffering from it. It is most important that any case should be noticed at once, and proper care taken of it. But in addition to this, caps, brushes, combs, and anything coming into contact with the infected person must not be used by others. It is better that these things should be burned. Children suffering from ringworm should not go to school nor to a barber.



a, A healthy hair as seen by the microscope.
b, A hair infected with the germ of ringworm.

One great means which we must use in the prevention of all diseases is that, by attending to the ordinary rules regarding cleanliness, fresh air, exercise, rest, and food, we should keep the body strong, so that we may be able to resist attacks of disease. In any case, if we are careful in following out the laws of health, we are less likely to be seriously affected by illness, can throw it off more rapidly and thoroughly when it comes,

and can regain our full strength quickly when the disease has passed away.

QUESTIONS—

1. What is meant by the term "infectious diseases"?
2. How do infectious diseases spread?
3. Name some of the common infectious diseases.
4. How is the spread of infection prevented?
5. What is ringworm?
6. How does ringworm spread, and what should be done to prevent its spreading?

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